9. Mimulus verbenaceus Greene, Leafl. Bot. Obs. & Crit. 2: 2. 1909.

The natural habitat of this species is montane in the origins of streamways, such as rocky seeps and waterfalls in canyons where permanent moisture is available. In such situations it is often found in low bushy clumps. Occasionally it occurs in a less cespitose form along the lower river courses, as near Fuerte, but the seasonal floods sweeping such rocky river beds alternately initiate and destroy lowland adventives of the species.

Known from the Grand Canyon, Arizona, to northern Sinaloa. Sinaloa, Mexico: above La Jolla, Sierra Surotato, *Gentry 7284;* sandy soil along the river near Fuerte, *Rose, Standley, & Russel 13074.* Grant (*op. cit.,* 144) cites Sierra de Alamos as in Sinaloa. This is an error since that mountain is in Sonora.

Publication no. 838 from Botany Department,
University of Michigan, Ann Arbor.

LOCATION OF EXTRANEOUS MATERIALS IN REDWOOD

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This paper is one of a series originating from the laboratories of The Institute of Paper Chemistry, Appleton, Wisconsin, and covering a fundamental study of the botanical, chemical and other characteristics of the California redwood (*Sequoia sempervirens*); this work has been sponsored by The Pacific Lumber Company, Scotia, California.

In order to study the location of extraneous materials in redwood and the effect of certain treatments on these substances, microsections (20 μ thick) were made from the following locations in a redwood tree—namely, outer portion of heartwood, sapwood, junction of sapwood and heartwood, and rootwood. The major portion of the work was done on the heartwood sections. The treatments used on the various sections and the results obtained are, for the most part, described briefly in Table 1.

Heartwood

In the heartwood the extraneous material is located chiefly in the cell cavities of the wood ray parenchyma and the longitudinal parenchyma but may also be present in the walls of these cells as well as in the walls of the tracheids, the only other type of cell structure present in redwood (pl. 1, figs. 1, 2). This extraneous material includes mainly dead protoplasm, proteins, starch, tannins, phlobaphenes, and fats, and is dark red in color, especially in the longitudinal wood parenchyma cells.

The reaction of the cell contents to the various reagents, as

Table 1. Effect of Reagents on Cell Contents

Treatment	Appearance and Results
	Heartwood
None	Dark red (especially the longitudinal wood parenchyma).
Dilute ferric chloride	Cell contents bluish black.
Cold alcohol for 5 minutes	Considerable amount of cell contents dissolved.
Hot alcohol	Some cell contents still remain, located mainly in ray parenchyma.
Hot water for 3 hours (following hot alcohol)	Small amount of cell contents still retained.
Hot dilute alkali (1% NaOH) for 3 hours (following alcohol and water)	All extraneous material removed. Cell walls greenish, slightly swollen.
	Sapwood
Dilute ferric chloride	Only a small amount of cell contents affected in color, and then only slightly.
Cold alcohol	Considerable amount of material remains, yellow in color.
	Rootwood
None	Light to dark brown in color.
Dilute ferric chloride	Color darkened, but not uniformly.
Hot alcohol	Considerable amount of material of various shades of brown persists.
Acidulated alcohol (3% acetic acid) for 3 hours	Tannates converted to tannins; large amount of extraneous material retained.
Hot water for 3 hours (following acidulated alcohol)	Some extraneous material remains (pl. 2, fig. 3).
Hot dilute alkali (1% NaOH) for 2 hours (following alcohol and water)	All extraneous material removed; cell walls greenish yellow (pl. 2, fig. 4).

well as the analytical data reported elsewhere by Lewis [Chemical Nature of Redwood, The Vortex, 7(5): 218. May, 1946], indicate a considerable amount of tannin and phlobaphene in the heartwood. For comparison, these data are presented in Table 2.

If the cross-sections, which have been previously extracted with hot alcohol for three hours and hot water for three hours, are treated alternately with chlorine gas and a 3 per cent alcoholic solution of monoethanolamine in such a way as to dissolve the lignin without hydrolysis of the non-cellulosic carbohydrates the holocellulose is left. The visible effect (pl. 1, fig. 3) of the lignin solvent is a removal of the intercellular material so that the cells pull apart by themselves or at the touch of a dissecting needle. The summerwood ring seems particularly susceptible to handling. It is impossible to obtain other than very small sections of holocellulose unless the treated section is handled on a microslide

throughout the operation. After the holocellulose is prepared, a piece is treated with 72 per cent sulfuric acid; if it dissolves (leaving only minute traces), it is considered that the lignin has been removed during the preparation of the holocellulose. When the holocellulose is treated with dilute sulfuric acid to remove the easily hydrolyzable carbohydrates and leave a material closely resembling Cross and Bevan cellulose, the structure does not appear to change.

Table 2. Amount of Tannin and Phlobaphene in Redwood
(Based on oven-dry wood)

	Per cent of tannin	Per cent of phlobaphene
Heartwood	4.1	6.2
Sapwood	0.2	0.7
Rootwood	7.8	22.1

When extractive-free cross sections are treated with 72 per cent sulfuric acid to remove the carbohydrates and leave the framework of lignin, the cell walls immediately turn green and begin to swell. Since the walls of the summerwood cells are much thicker than those of the springwood cells, the swelling is greater and the summerwood is distorted considerably. This swelling causes a loss of identity in some of the summerwood cells, especially if the acid is removed and the section is washed and dehydrated preparatory to making a permanent slide mount. After a brief period of exposure to the concentrated acid the structure turns brown but continued contact apparently causes no further action (pl. 1, fig. 4).

Sapwood

Although considerable extraneous material is present in the cell cavities of parenchymatous cells in the sapwood, they do not appear to contain much tannin. This observation is in agreement with the low tannin content of the sapwood as determined analytically.

Rootwood

The rootwood contains large amounts of extraneous materials and many of the tracheids are filled, in addition to the ray parenchyma and longitudinal parenchyma cells (pl. 2, figs. 1, 2). This extraneous material is light brown to dark brown in color.

Uses and Summary

Redwood makes an interesting plastic pulp because of the tannin and phlobaphene present. These substances flow under high pressures and serve as binders. Unfortunately, in rootwood the fibers are not suitable and the resin content is too high for this

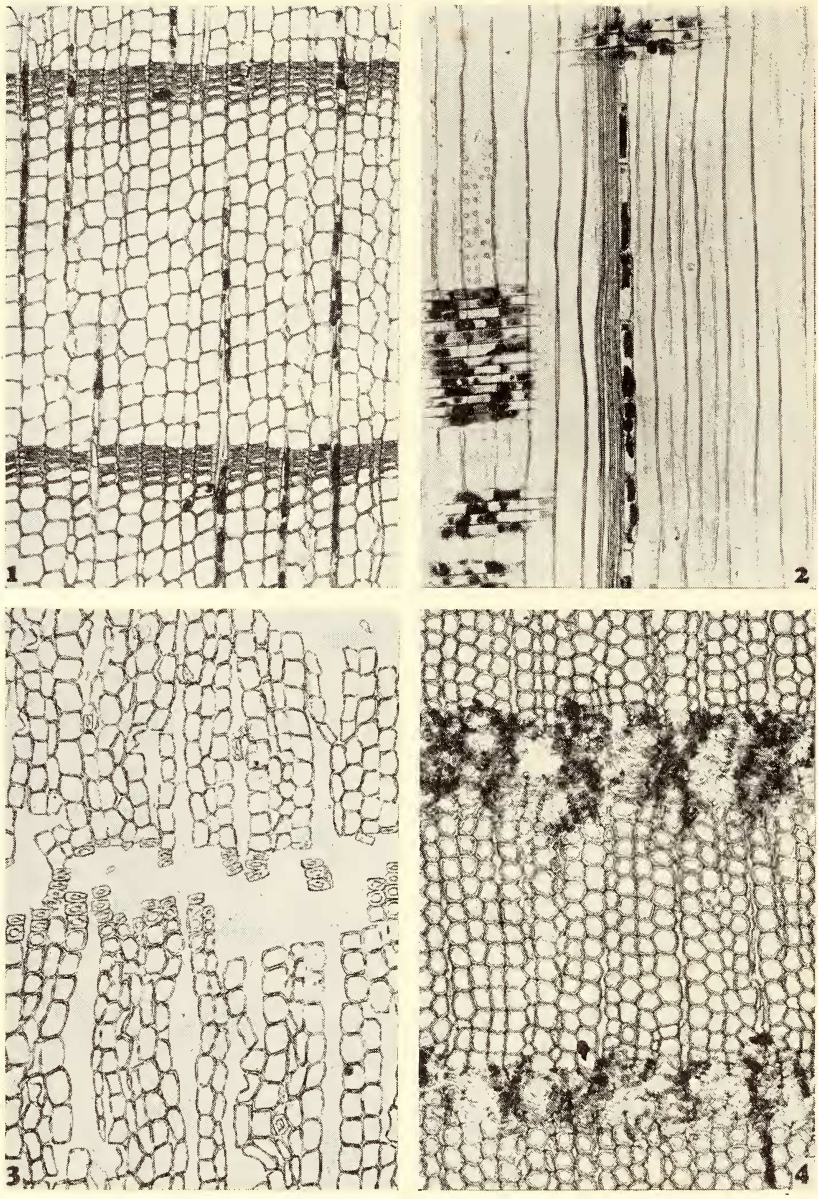

PLATE 1. HEARTWOOD OF SEQUOIA SEMPERVIRENS. FIG. 1. Transverse section. FIG. 2. Radial section. FIG. 3. Transverse section showing holocellulose. FIG. 4. Transverse section after treatment with 72 per cent sulfuric acid. (All $\times 50$.)

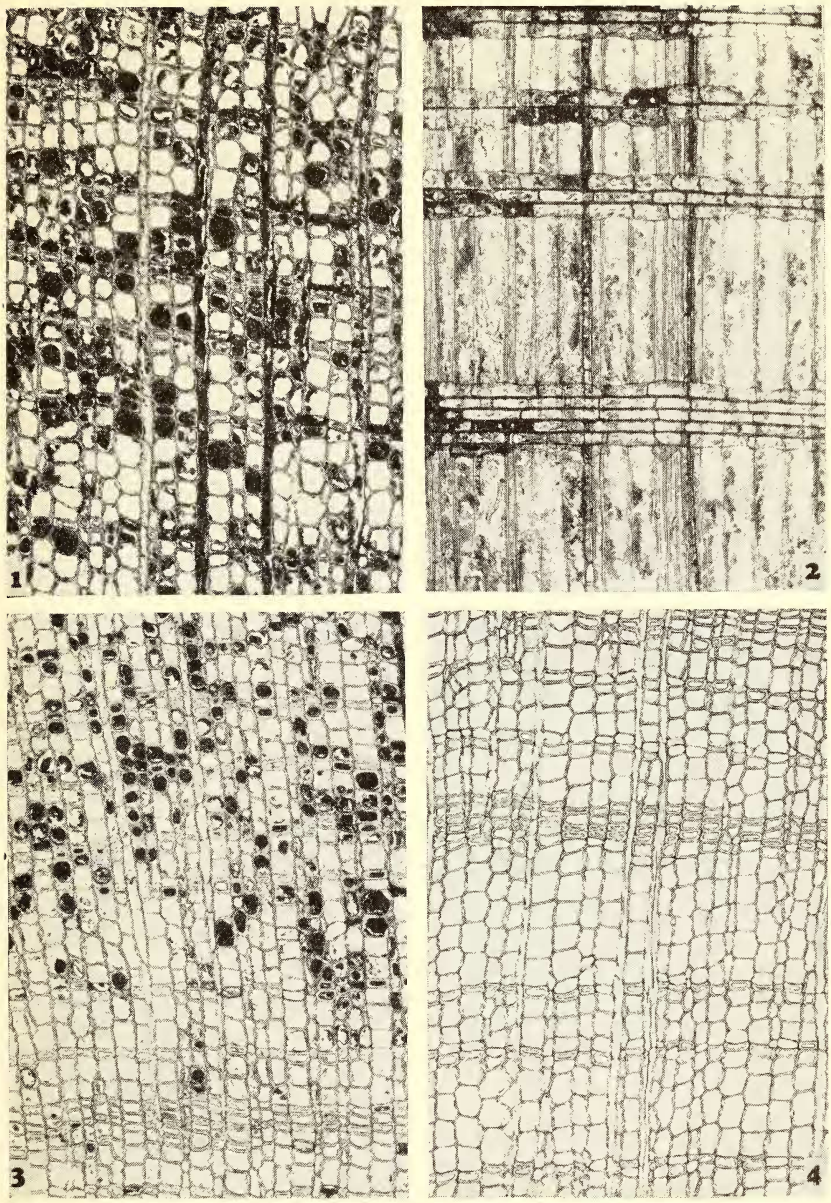

PLATE 2. ROOTWOOD OF SEQUOIA SEMPERVIRENS. FIG. 1. Transverse section. FIG. 2. Radial section. FIG. 3. Transverse section after 3 hours extraction with hot acidulated alcohol (3 per cent acetic acid) and 3 hours extraction with hot water. FIG. 4. Transverse section extracted for 2 hours with 1 per cent sodium hydroxide in addition to treatment with hot acidulated alcohol and hot water. (All $\times 50$.)

purpose. However, it is of interest as a source of extractive materials.

Tannin from redwood is a good tanning agent and anti-oxidant; the phlobaphene is a source of catechol on vacuum destructive distillation. Roots and stumps on destructive distillation yield a tar richer in phenol, creosol, guiacol, and *p*-cresol than that obtained from sapwood and heartwood. Although the tannin is not highly toxic it does help, with related materials, to make the heartwood rot resistant.

It appears from this study that most of the tanniferous material present in redwood is located in ray parenchyma and longitudinal parenchyma cells. The cell walls must contain some also, because it is unlikely that solutions would not diffuse into the walls.

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REVIEW

The Pacific Coast Ranges. Edited by Roderick Peattie. Contributors Archie Binns, John Walton Caughey, Lois Crisler, Aubrey Drury, Idwal Jones, Donald Culross Peattie, Thomas Emerson Ripley, Richard Joel Russell, Judy Van der Veer, and Daniel C. Willard. 402 pp. 4 maps. 29 illustrations. $3.75. The Vanguard Press, New York. 1946.

This volume is the fourth in a popular series of books written about the American mountains. The three previous volumes have been published under the titles *The Rocky Mountains, The Great Smokies and the Blue Ridge,* and *The Friendly Mountains* (Green, White, and Adirondacks). In this volume, *The Pacific Coast Ranges,* a capable editor and equally capable contributors have presented in non-technical language and in a narrative form an exceptional amount of general scientific and historical information. The scope and varied nature of the subject matter make a detailed review difficult and impractical. However, an outline of the thirteen chapters or narratives will give an idea of the extensive subject matter treated.

The California missions and the first peoples of the Coast Ranges furnish the subject material for the first two chapters, "Father Serra's Rosary," by Donald Culross Peattie and "The First Inhabitants of the Coast Ranges," by John Walton Caughey. The two authors give slightly different interpretations of the fate of the Indians upon secularization of the missions. In the first chapter, page eleven, we read:

> The missions were secularized, that is reduced to parish churches with a single priest, and stripped of everything except the immediate buildings themselves. First, many of the pioneering padres who had been men of education and high ideals, were supplanted by inferior friars,